IN THE CLAIMS:

1. (currently amended) A method for a medical examination using a magnetic resonance imaging (MRI) machine comprising:

polar phase encoding to generate a plurality of signals forming datasets representative of an object by frequency encoding in a Z-direction of a k-space, wherein the datasets form an elliptical grid in polar coordinates in the k-space, the Z-direction substantially parallel to a center axis of the elliptical grid, wherein said phase encoding comprises phase encoding in which each datum is represented as m(acos(2πd/n)kx + bsin(2πd/n)ky + ickz, a, b, c, and d are real numbers, m, n, and i are an integers, and kx, ky, and kz being unit basis vectors in the k-space; [[and]]

forming a nested loop, the nested loop comprising:

frequency encoding n1 times along a kz axis by keeping m, a, d, b, n, and c constant, and varying i;

phase encoding radially once by keeping a, d, b, n, and c constant and varying m for every n1 number of times of frequency encoding;

phase encoding radially for n2 number of times;

phase encoding rotationally once by keeping a, b, n, and c constant and varying d for every n2 number of times of radial phase encoding; and

phase encoding rotationally for n3 number of times.

2. (previously presented) A method in accordance with Claim 1 wherein said phase encoding comprises phase encoding on to the elliptical grid in polar coordinates in the k-space to generate magnetic resonance signals representative of the object.

3. (canceled)

4. (original) A method in accordance with Claim 1 wherein said phase encoding comprises phase encoding on to at least one plane encompassing a finite region in the k-space, each plane passing through a kz axis of the k-space.

5. (original) A method in accordance with Claim 1 wherein said phase encoding comprises phase encoding on to at least one of:

planes in the k-space;

groups of planes in the k-space;

a first set of regions formed by intersection of the planes with cylinders in the k-space;

a second set of regions formed by intersection of groups of planes with the cylinders;

a third set of regions formed by intersection of the planes with the groups of planes, the first set of regions, and the second set of regions; and

a fourth set of regions formed by union of the planes with the groups of planes, the first set of regions, and the second set of regions, wherein each of the planes and each plane in the groups of planes encompassing a finite region in the k-space, each of the planes being parallel to each other, each plane in each group being parallel to any other plane in the group, and each group being at an angle to any other group.

6. (original) A method in accordance with Claim 1 wherein said phase encoding comprises phase encoding on to a plane in the k-space.

7. (original) A method in accordance with Claim 6 further comprising constructing a 2-dimensional (2D) image by:

performing a 2D inverse Fourier transformation of the datasets.

8. (original) A method in accordance with Claim 6 further comprising constructing a 2-dimensional (2D) image by:

re-gridding datasets located on the plane on to a grid of Cartesian coordinates; and

performing a 2-dimensional backprojection of datasets located on the plane.

9. (original) A method in accordance with Claim 1 wherein said phase encoding comprises phase encoding on to a series of groups of planes in the k-space, wherein each group is at an angle relative to any other group in the series.

10. (original) A method in accordance with Claim 9 further comprising constructing a 3-dimensional (3D) image by:

performing an inverse Fourier transformation, in kz direction, of datasets located on each group in the series; and

performing a 2-dimensional (2D) inverse Fourier transformation, in kx and ky directions, of datasets located on each group in the series.

11. (original) A method in accordance with Claim 9 further comprising constructing a 3-dimensional (3D) image by:

performing an inverse Fourier transformation, in kz direction, of datasets located on each group in the series; and

performing a 2-dimensional backprojection, along kx and ky directions, of datasets located on each group in the series.

12. (original) A method in accordance with Claim 9 further comprising obtaining a high temporal resolution by performing a 2-dimensional inverse Fourier transformation of datasets located on a plane of a group in the series.

13. (original) A method in accordance with Claim 9 further comprising obtaining a high temporal resolution by:

re-gridding datasets located on a plane of a group in the series, wherein the re-gridding is performed on a grid of polar coordinates; and

performing a 2-dimensional backprojection of datasets located on the plane of the group.

14. (original) A method in accordance with Claim 9 further comprising obtaining a low temporal resolution by:

performing an inverse Fourier transformation in kz direction of datasets located on each groups in the series;

re-gridding datasets located on each group in the series, wherein the re-gridding is performed along kx and ky directions; and

performing a 2-dimensional inverse Fourier transformation in kx and ky directions of datasets located each group in the series.

15. (original) A method in accordance with Claim 9 further comprising obtaining a low temporal resolution by:

performing an inverse Fourier transformation in kz direction of datasets located on each group in the series; and

performing backprojection in kx and ky directions of datasets located on each group in the series.

16. (original) A method in accordance with Claim 9 further comprising obtaining a medium temporal resolution by:

performing a 3-dimensional inverse Fourier transformation of datasets located on a group in the series;

performing a maximum intensity projection of datasets located on the group in the series.

17. (original) A method in accordance with Claim 9 further comprising obtaining a medium temporal resolution by performing a 3-dimensional backprojection of datasets located on a group in the series.

18. (original) A method in accordance with Claim 17 further comprising performing a maximum intensity projection of datasets located on the group.

19. (original) A method in accordance with Claim 9 further comprising:

constructing a 3-dimensional (3D) image from datasets located each group in the series; and

updating the 3D image by:

phase encoding on to a first group in the series;

constructing a 3D image from datasets located on each group in the series after phase encoding on to the first group;

phase encoding on to a second group in the series;

constructing a 3D image from datasets located on each group in the series after phase encoding on to the second group;

phase encoding on to a third group in the series; and

constructing a 3D image from datasets located on each group in the series after phase encoding on to the third group.

20. (original) A method in accordance with Claim 1 wherein said phase encoding comprises phase encoding on to a group of planes in the k-space, each plane in the group being parallel to any other plane in the group.

21. - 24. (cancelled)

25. (currently amended) A magnetic resonance (MR) method for medical examinations comprising:

injecting a patient with a contrast agent that flows into a vasculature of the patient;

acquiring MR signals produced by spins in the vasculature from an MR imaging system;

polar phase encoding to generate the MR signals forming datasets representative of the patient by frequency encoding in a Z-direction of a k-space, wherein the datasets form an elliptical grid in polar coordinates in the k-space, the Z-direction substantially parallel to a center axis of the elliptical grid, wherein said polar phase encoding comprises phase encoding in which each datum is represented as $m(a\cos(2\pi d/n)kx + b\sin(2\pi d/n)ky) + jr(a\cos(2\pi d/n)kx + b\sin(2\pi d/n)ky) + ickz$, a, b, c, d, and r are real numbers, m, j, n, and i are an integers, and kx, ky, and kz being unit vectors in the k-space; and

forming a nested loop, the nested loop comprising:

frequency encoding the datasets m1 times along a kz axis by keeping m, a, d, n, b, j, r, and c constant, and varying i;

phase encoding radially once by keeping a, d, n, b, j, r, and c constant and varying m for every [[n1]] m1 number of times of frequency encoding;

phase encoding radially for m2 number of times;

phase encoding translationally once by keeping a, d, n, b, r, and c constant and varying j for every m2 number of times of radial phase encoding;

phase encoding translationally for m3 number of times;

phase encoding rotationally once by keeping a, n, b, r, and c constant and varying d for every m3 number of times of translational phase encoding; and

phase encoding rotationally for m4 number of times.

26. (currently amended) A method for a medical examination using a magnetic resonance imaging (MRI) machine comprising:

sampling datasets on to an elliptical grid in polar coordinates in a k-space to generate signals representative of an object of interest that is being medically examined, wherein the dataset are frequency encoded in a Z-direction of the k-space, the Z-direction substantially parallel to a center axis of the elliptical grid, said sampling comprises phase encoding in which each datum is represented as m(acos(2πd/n)kx + bsin(2πd/n)ky + ickz, a, b, c, and d are real numbers, m, n, and i are an integers, and kx, ky, and kz being unit basis vectors in the k-space; and

forming a nested loop, the nested loop comprising:

frequency encoding n1 times along a kz axis by keeping m, a, d, b, n, and c constant, and varying i;

phase encoding radially once by keeping a, d, b, n, and c constant and varying m for every n1 number of times of frequency encoding;

phase encoding radially for n2 number of times;

phase encoding rotationally once by keeping a, b, n, and c constant and varying d for every n2 number of times of radial phase encoding; and

phase encoding rotationally for n3 number of times.

27. (cancelled)

28. (currently amended) A magnetic resonance imaging (MRI) system comprising:

a main magnet to generate a uniform magnetic field;

a radio frequency pulse generator for exciting the magnetic field;

a gradient field generator for generating gradients extending in different directions in the magnetic field;

a receiver for receiving ~~magnetic field~~ magnetic resonance (MR) signals representative of an object; and

a controller for polar phase encoding to generate the MR signals forming datasets representative of the object by frequency encoding in a Z-direction of a k-space, wherein the datasets form an elliptical grid in polar coordinates in the k-space, the Z-direction substantially parallel to a center axis of the elliptical grid, said controller configured to:

phase encoding by representing each datum as m(acos(2πd/n)kx + bsin(2πd/n)ky + ickz, a, b, c, and d are real numbers, m, n, and i are an integers, and kx, ky, and kz being unit basis vectors in the k-space; and

form a nested loop, the nested loop comprising:

frequency encoding n1 times along a kz axis by keeping m, a, d, b, n, and c constant, and varying i;

phase encoding radially once by keeping a, d, b, n, and c constant and varying m for every n1 number of times of frequency encoding;

phase encoding radially for n2 number of times;

phase encoding rotationally once by keeping a, b, n, and c constant and varying d for every n2 number of times of radial phase encoding; and

phase encoding rotationally for n3 number of times.

29. (currently amended) A magnetic resonance (MR) controller programmed to:

polar phase encode to generate a plurality of magnetic resonance (MR) signals forming datasets representative of an object by frequency encoding in a Z-direction of a k-space, wherein the datasets form an elliptical grid in polar coordinates in the k-space, the Z-direction substantially parallel to a center axis of the elliptical grid, wherein said polar phase encoding comprises phase encoding in which each datum is represented as $m(a\cos(2\pi d/n)kx + b\sin(2\pi d/n)ky) + jr(a\cos(2\pi d/n)kx + b\sin(2\pi d/n)ky) + ickz$, a, b, c, d, and r are real numbers, m, j, n, and i are an integers, and kx, ky, and kz being unit vectors in the k-space; and

form a nested loop, the nested loop comprising:

frequency encoding the datasets m1 times along a kz axis by keeping m, a, d, n, b, j, r, and c constant, and varying i;

phase encoding radially once by keeping a, d, n, b, j, r, and c constant and varying m for every [[n1]] m1 number of times of frequency encoding;

phase encoding radially for m2 number of times;

phase encoding translationally once by keeping a, d, n, b, r, and c constant and varying j for every m2 number of times of radial phase encoding;

phase encoding translationally for m3 number of times;

phase encoding rotationally once by keeping a, n, b, r, and c constant and varying d for every m3 number of times of translational phase encoding; and

phase encoding rotationally for m4 number of times.

30. (previously presented) A method in accordance with Claim 1 wherein each datum of the datasets is represented as a function of at least one of a cosine function and a sine function.

31. (previously presented) A method in accordance with Claim 1 wherein at least a portion of the datasets is acquired along a radius.